CPower

A NEW AGE

of Demand-Side Energy Management:

Data Centers

DATA CENTERS

have a unique opportunity at this pivotal moment in energy's history.

That's because the energy assets most data centers in the US currently possess energy assets that have the potential to help the grid as it transitions to a cleaner, more dependable and sustainable future.

Data centers that provide these flexible energy resources when the grid needs them can help the environment while optimizing their own infrastructure and ensuring their own uptime. They can also earn significant revenue.

Most importantly, data centers that participate in demand-side energy management become pillars of their community. The sheer magnitude of their available energy load and demand reduction can help keep the grid reliable for all local organizations and homes.

Data centers participating in demand-side energy management also ensure that costly and dirty peaker plants stay on the sidelines of the grid operator's playbook when demand for electricity exceeds supply—imbalances that are becoming more frequent due to increasingly adverse weather and changes in power supply and demand.

In the pages that follow, we will explore and explain the specific ways demand-side energy management can and should become an integral component of any data center's infrastructure management strategy.

Some of the topics we'll cover on our journey include:

- The current state of the grid as it transitions to a cleaner future
- Distributed energy resources in a data center's arsenal
- How demand-side energy management (DSEM) helps data centers optimize their infrastructure, reduce their carbon footprint, and earn money in the process
- Energy efficiency opportunities for data centers (and how to monetize them)
- Demand response for data centers (and how to earn revenue by using less electricity)
- The importance of testing backup generators under load
- How to assess if your data center is a prime candidate for DSEM (chances are, it is.)

Let's take the first step across your data center's customizable bridge to energy's future.

CPower has helped data centers nationwide serve their communities and earn revenue for helping the grid.

Contact us if you have any questions about anything in this book.

Learn more about how CPower helps Data Centers

Data centers possess the flexible energy resources to help the grid AND help their local community's sustainability.

Electric grids that bring power to the American people are increasingly integrating more clean and renewable energy sources.

Welcome as this integration is, it poses a challenge.

To maintain the balance between supply and demand as more front-of-the-meter clean energy sources such as wind and solar are integrated into the electric grid, grid operators and utilities need the flexibility of behind-the-meter distributed energy resources (DERs) from large-scale commercial and industrial organizations such as data centers.

That's because wind and solar energy sources are inherently intermittent. Wind turbines won't turn if the wind isn't blowing. Solar cells won't produce electricity when the sun isn't shining.

DERs and the commercial organizations that possess them can provide exactly the support the grid needs both when Mother Nature falls short or overwhelms the grid with extreme weather events that wreak havoc on the grid's energy supply.

DERs can also infuse a needed boost when other non-weather-related situations cause demand on the grid to outpace supply.

These flexible, behind-the-meter resources that data centers and other large commercial organizations possess are extremely valuable to grids across America during this transition toward a cleaner, more sustainable energy future.

Part of turning the potential of your energy assets into reality includes using them to achieve your sustainability goals.

CPower can help you do just that.

FPO

Good for the Grid. Great for the Community.

Prior to the COVID pandemic, data centers comprised one of the most energy-intensive industries in the world, with the average data center in the US consuming up to 50 times the electricity of a comparably sized commercial office building.

As the lockdown drove America to shelter in place, increased home computing across the country created the kind of spike in ones and zeros that the data center industry was born to house. Now, the sector looks to a bright future with an eye on growth, efficiency, and sustainability.

The pressure, however, is mounting for an industry facing exponential growth and increased responsibility. Not only is the sector expected by its customers to run 24/7/365 without a second of downtime, but it must also comply with social demands of keeping its energy use and subsequent carbon footprints in check.

By practicing optimized, demand-side energy management, data centers have the opportunity to be the pillars of their communities, supporting the grid for the benefit of the ratepayers and all who rely on it.

Data Centers and Demand-Side Energy Management to the Rescue

At its essence, demand-side energy management seeks to alleviate grid stress preemptively so that homes and businesses in a given community never experience a brownout or (worse) a blackout.

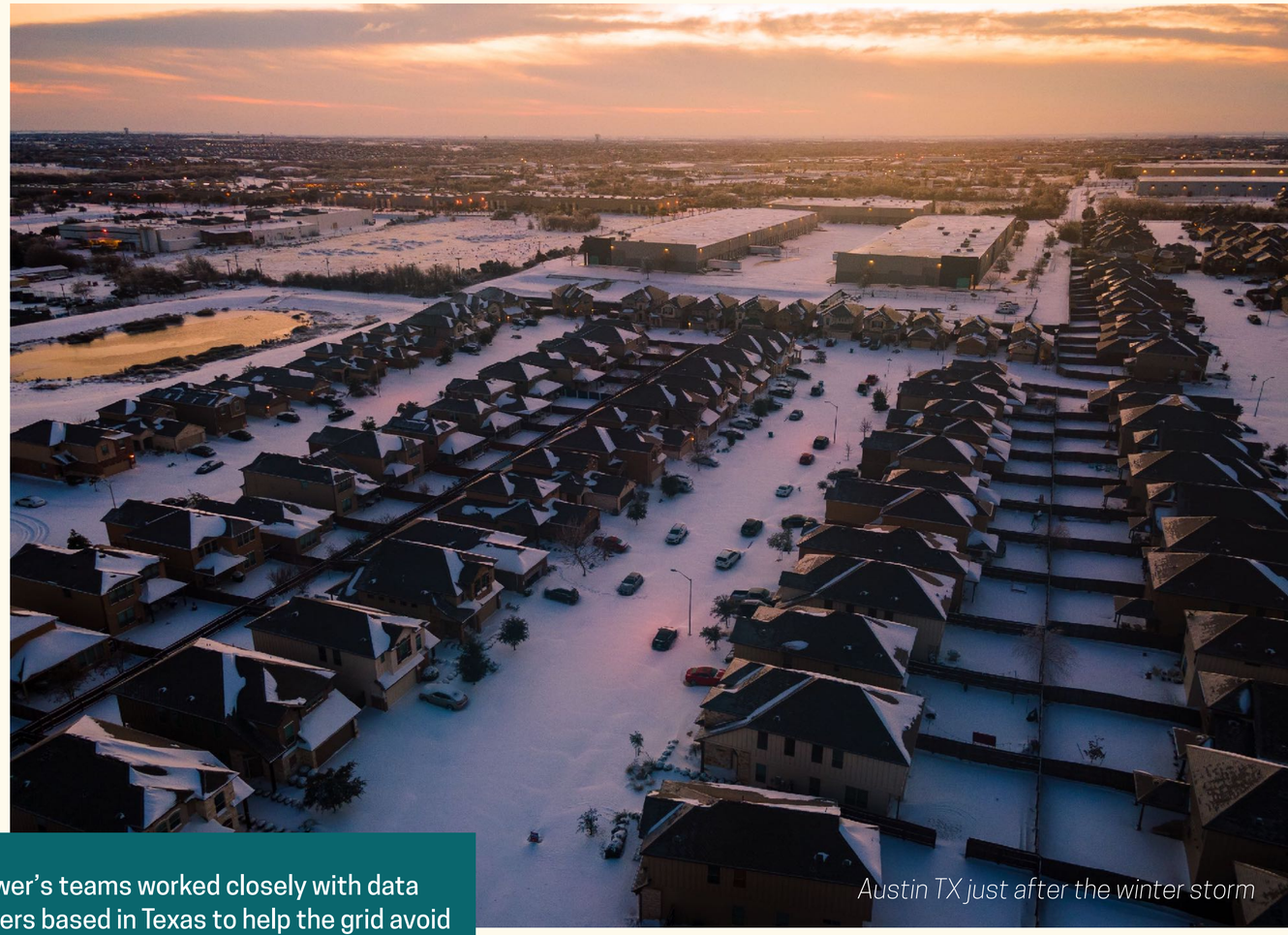
With their power and water demands, data centers may have at one time been seen as potential detriments to local communities' grids. Demand-side energy management flips the script and allows data centers to use their loads in a way that supports grid balance so the people of their community never lose power.

Unfortunately, extreme weather has a way of rearing its ugly head at the most inopportune times, inflicting tragic damage on an electrical grid as was experienced in California in August of 2020, Texas in February of 2021, and Louisiana in September of 2021. The states experienced significant blackouts that affected millions of people, many of whom are still impacted as infrastructure repairs are still being made.

In the case of the Texas blackout, data centers played a critical role at a time when the grid was mere minutes away from experiencing a complete shutdown.

By contributing their excess capacity via the grid operator's ancillary service demand response program, data centers played an integral role in ensuring the grid maintained the necessary frequency to remain online in a pattern of rolling blackouts.

Without the contribution from data centers and others, the grid would have experienced a system into a shutdown that officials have said would have taken weeks to restore.



Austin TX just after the winter storm

FPO

CPower's teams worked closely with data centers based in Texas to help the grid avoid a long term shutdown.

Achieving Carbon Emission Goals with Demand-Side Energy Management

A convergence of pressures in recent years has caused organizations across North America to examine how their energy use can be managed to help achieve their carbon reduction goals.

These converging pressures originate from customers, who desire to do business with sustainability-minded companies; investors, who realize the inherent value associated with an organization being carbon neutral; and regulators, who are introducing laws that reflect and address society's move toward a cleaner energy future.

Since these pressures show no signs of waning, the question of exactly how demand-side energy management can be optimized to achieve carbon goals is becoming a popular discussion in the data center industry today.

Some of the best practices for carbon-reducing with demand-side energy management are more obvious than others. Adopting energy efficiency measures or installing on-site renewable energy sources like solar are examples of strategies that have been around for decades.

Let's examine, then, some of the newer concepts in the data center industry on the topic of achieving carbon goals using demand-side energy management tactics.

Data Centers Can Help the Grid Maintain Cleaner Energy Mixes

Naturally, how an organization uses energy can have a large impact on carbon emissions, but when energy is consumed from the grid can move the carbon reduction needle, too. By shifting energy usage to a time when the grid mix is cleaner—during the middle of the day when solar is more prevalent compared with coal, for example—overall emissions are lowered.

Consider California, where an abundance of solar energy resources (in front of and behind the meter) provide a significant amount of the energy consumed during daytime hours.

California has long been a national leader in the driver to a carbon-free energy future. During the day, the state's energy mix is as clean as any in the country, perhaps even cleaner.

The challenge for much of the Golden State takes place each evening when the sun sets, solar resources go offline, and the grid experiences an evening spike in electricity demand from air conditioning and other added loads—a phenomenon known as "The Duck Curve."

Here is an instance where flexible, demand-side resources from commercial organizations such as data centers can help the grid maintain balance and avoid having to fire up expensive, dirty peaker plants to accommodate the evening net load ramp.

Data centers across the country are helping their local grids maintain clean energy mixes by practicing demand-side energy management in a similar fashion. By doing so, they are not only contributing to their local communities' sustainability, but they are also supporting the grid for the people in their local communities whose lives fundamentally depend on electricity.

An increasing number of organizations and cities have sought to eliminate their emissions in the time period when they consume electricity, often in hour-by-hour increments. This is a practice called 24/7 Clean Energy.

The more generation mixes shift toward renewable sources and as more DERs integrate into the grid with help of regulations like FERC Order 2222, the more the 24/7 clean energy effect should increase. That is, an increase in peak renewable generation will likely result in a larger potential emission reduction due to the load having been shifted.

Companies, regulators, and markets are in the early stages of ascribing a value to 24/7 clean energy practices.

CPower's data center customers provide critical power resources with their onsite energy storage, generation and added efficiency during challenging times, helping maintain grid stability and lowering emissions and costs for all.

FPO

Consider the drive toward a carbon-neutral future from the grid operator's perspective. Across the US, grids face the same converging pressures as organizations and have worked to increasingly shift their generation mixes away from fossil fuels and toward renewable sources like wind and solar.

Of course, wind and solar energy sources are inherently intermittent and can subsequently cease generating if the wind stops blowing or the sun stops shining.

But the immutable truth that some days are overcast and others windless doesn't ease the pressure on the grid and those who run it to drive toward carbon-neutrality! Nor does inescapable intermittency suffice as an acceptable reason for grid operators to sacrifice reliability in the name of sustainability.

So what's a grid operator to do?

Here is where commercial and industrial organizations can fill the gap from the demand side and help the US electrical grid find its way to the clean and efficient energy future that everyone desires.

That the grid needs flexible resources which can be dispatched quickly to serve load when it's needed due to wind and solar generation being unavailable is a central point readers of this book should be quite familiar with, given it's been a topic in the energy industry over the last few years.

The same is true of the role demand response plays in providing that flexibility to the grid.

CPower will work with your data center to evaluate and implement demand-side energy strategies that support the grid and your organization.

Watch the Video: Monetizing Energy Efficiency

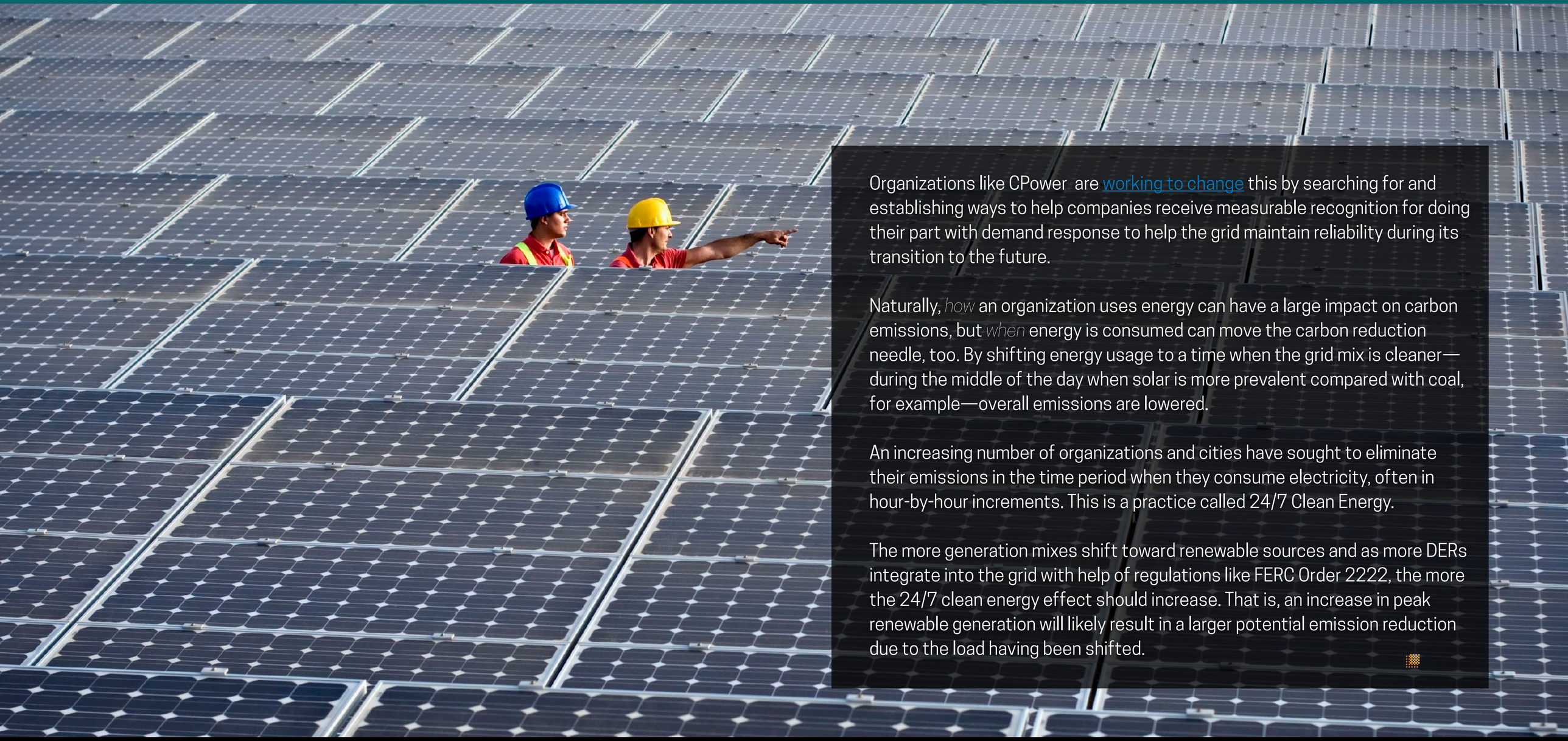
What's becoming more apparent is how increased participation in demand response programs at the ISO and utility levels across the US is providing new tools for grid operators to harmonize their grids' reliability with their drive toward a future of cleaner generation fuel mixes.

In effect, this demand-side participation enables the firming of renewable energy sources, allowing grids to transition toward cleaner fuel mixes. While demand response participation doesn't directly help individual organizations achieve their own carbon reduction goals, the cumulative effect of all the organizations' participation does help our society achieve its desired emission goals.

The pressures organizations face from outside entities that we discussed earlier play a role in driving a given company's carbon-reduction goals.

Unfortunately, in a reward-based world dominated by measurable metrics, there isn't a practical way to note just how effective a given organization's demand response participation is in helping contribute to carbon and greenhouse gas reduction.

That's starting to change.



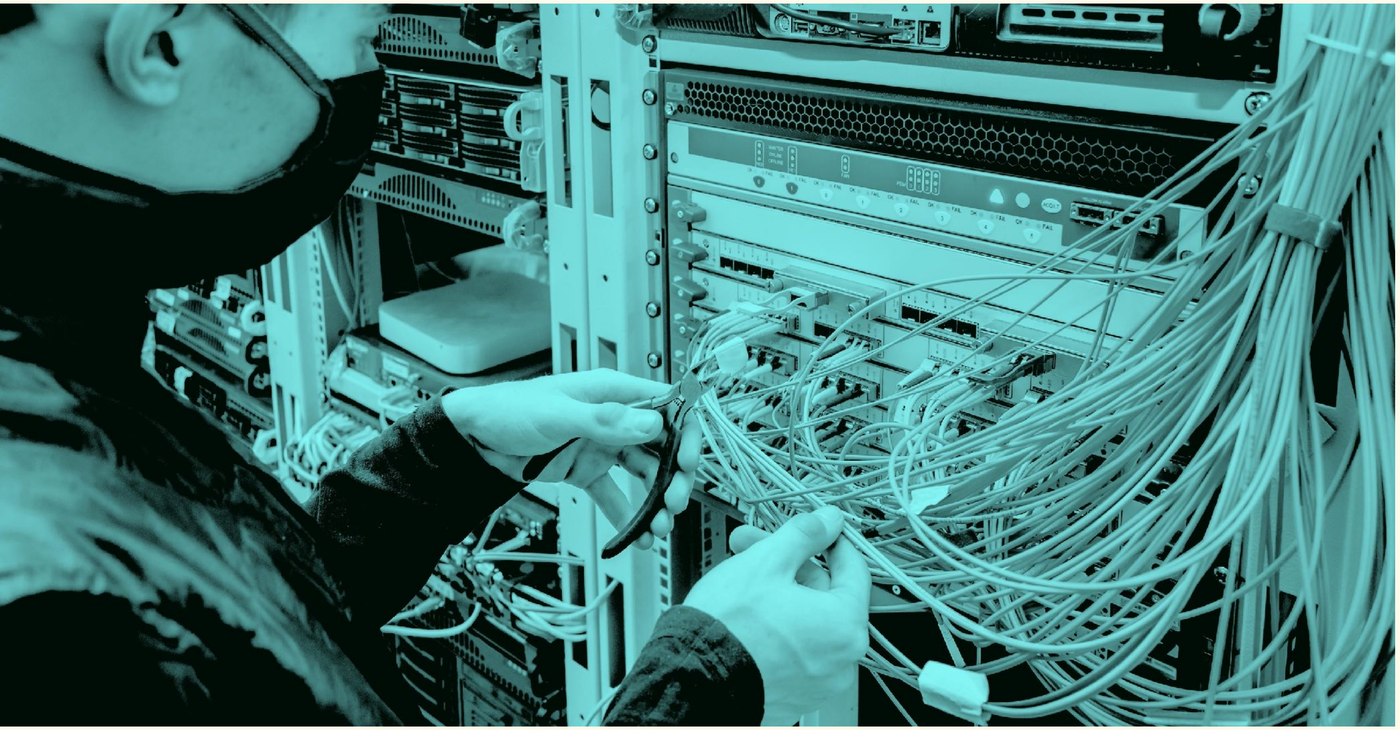
Organizations like CPower are working to change this by searching for and establishing ways to help companies receive measurable recognition for doing their part with demand response to help the grid maintain reliability during its transition to the future.

Naturally, *how* an organization uses energy can have a large impact on carbon emissions, but *when* energy is consumed can move the carbon reduction needle, too. By shifting energy usage to a time when the grid mix is cleaner—during the middle of the day when solar is more prevalent compared with coal, for example—overall emissions are lowered.

An increasing number of organizations and cities have sought to eliminate their emissions in the time period when they consume electricity, often in hour-by-hour increments. This is a practice called 24/7 Clean Energy.

The more generation mixes shift toward renewable sources and as more DERs integrate into the grid with help of regulations like FERC Order 2222, the more the 24/7 clean energy effect should increase. That is, an increase in peak renewable generation will likely result in a larger potential emission reduction due to the load having been shifted.

Learn more about how CPower helps Data Centers



The Pandemic and the Path Forward

Prior to the COVID pandemic, data centers comprised one of the most energy-intensive industries in the world, with the average data center in the US consuming up to 50 times the electricity of a comparably sized commercial office building.

As the lockdown drove America to shelter in place, increased home computing across the country created the kind of spike in ones and zeros that the data center industry was born to house. Now, the sector looks to a bright future with an eye on growth, efficiency, and sustainability.

The pressure, however, is mounting for an industry facing exponential growth and increased responsibility. Not only is the sector expected by its customers to run 24/7/365 without a second of downtime, but it must also comply with social demands of keeping its energy use and subsequent carbon footprints in check.

In short, the world has been watching and will continue to keep an eye on the data center industry in the coming years. Its reputation for the next decade may very well be determined by the sector's demand-side energy management strategies implemented and executed in the pivotal year of 2021 and going forward.

FPO

Green Data Centers and Energy Efficiency Capacity Rewards

Green data centers, which are environmentally responsible and resource-efficient, aim to lower costs while creating a more sustainable operation through improved design and by using more efficient equipment.

In 2018, the London-based research organization Technavio predicted the green data center market would grow at a compound annual rate of about 15% by the end 2021. The company didn't have the COVID pandemic in mind when it made the prediction, but their prognostication may still be within reach.

Data hosting organizations that have upgraded their existing facilities to be more energy efficient may be eligible to earn money for the permanent reduction of their electric demand by working with CPower so we may offer the reduced demand into grid operated forward capacity markets, like those of PJM and ISO-New England.

A sample energy efficiency project for a data center that reduced demand by upgrading its chilled water plant and retrofitting supply and return fans with variable speed fan drives (VFDs) might look like this:

Application	Total System Size	Total Verified Reduction
Chilled water plant upgrades including high efficiency, variable speed chillers and free cooling heat exchanger	400 Tons	900 kW
Retrofit supply and return fans with VFDs	400 HP	200 kW

Total of permanently reduced demand that can be offered into a capacity market: 1.1 MW

FPO

How Does Energy Efficiency Increase Local Sustainability?

Just over a megawatt of reduced demand may not seem significant from a sustainability standpoint until we quantify the positive effect successfully completed energy efficiency projects have on reducing carbon emissions into the environment.

According to the Environmental Protection Agency, a single megawatt of permanently reduced demand reduces greenhouse gas emissions equivalent to 3,533 metric tons of carbon dioxide.

To put that in perspective, that lone MW of permanently reduced demand preserves the environment by sparing it the greenhouse gas emissions from more than 8.9 million miles driven by an average passenger car.

Additionally, that single MW also spares the environment from carbon dioxide emissions equivalent to just under 4 million pounds of coal being burned.

While the environmental benefits of energy efficiency projects are substantial for participating data centers, the financial earnings are worth quantifying, too.

Monetized in the PJM capacity market, an energy efficiency project can yield an organization roughly $10/kW per year.*

For data centers whose core business of storing and processing megabytes is highly lucrative, that kind of monetary gain may seem small and not worth the effort. But when it comes to energy efficiency projects that permanently reduce megawatts of demand, there is no effort required on a data center's part.

The work has been done. The upgrades are complete.

From here, it's just a question of properly measuring & verifying the reduced demand, offering it into a capacity market and/or procuring a payment from a local electric utility, and then getting deserved recognition for your sustainability contribution.

This is what we at CPower do for you.

The payment for capacity varies in PJM depending on the locational deliverability area (LDA) from which the capacity is offered into the market.

FPO

How to Assess Your Data Center for Energy Efficiency Opportunities

Here are a few questions to consider about your data center and its potential to monetize energy efficiency projects.

Do you track your data center's Power Usage Effectiveness (PUE)?

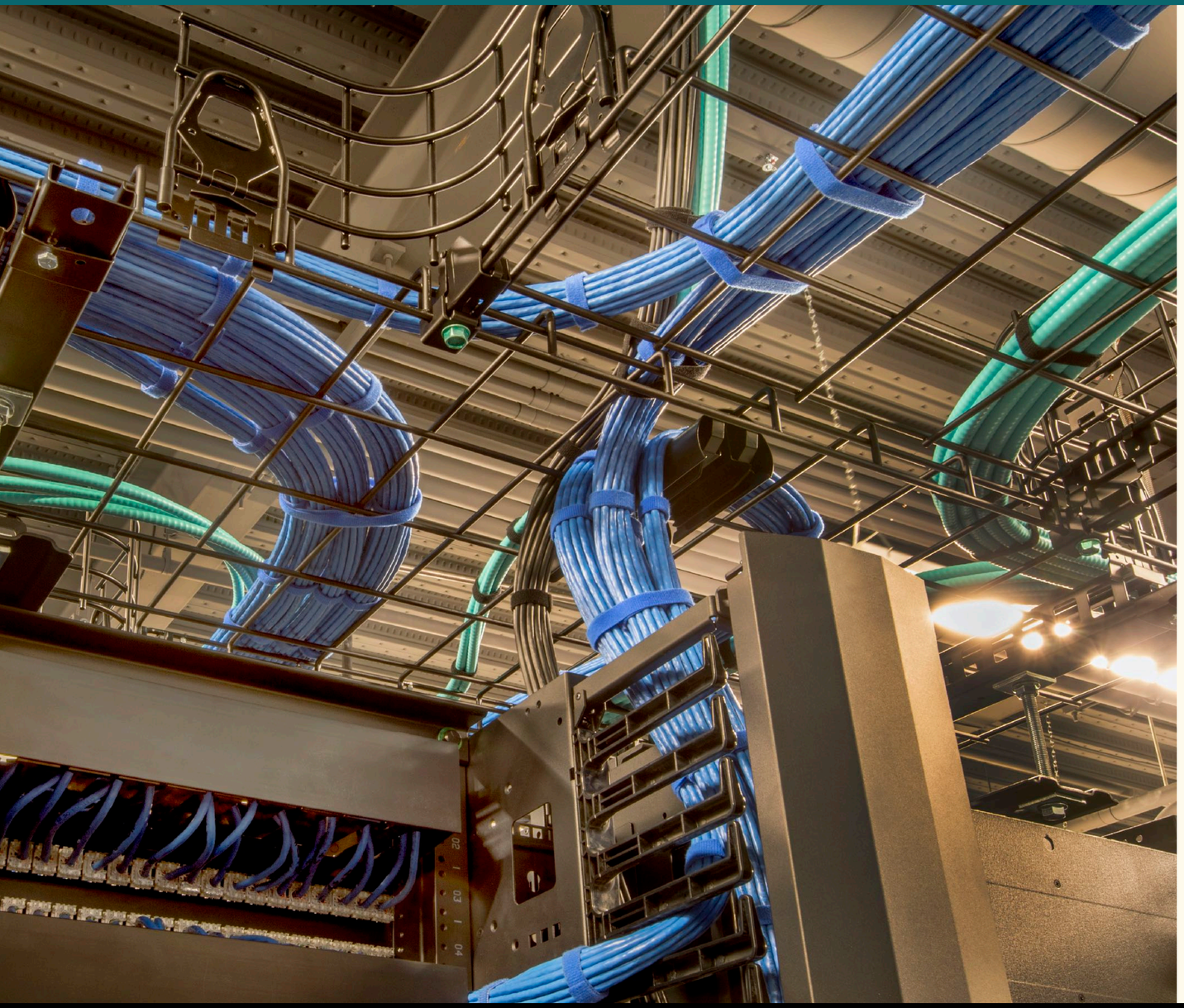
- What is your target annual PUE?
- What is your current operating PUE?
- How much seasonal variation between Summer (June-August) and Winter (January-February)?

What is your data center's design IT load?

- What is the current operating IT load? (or, percentage of full design capacity)
- What is the expected growth/lease rate for this year and to become fully leased / fully operational (typically 50-60% of actual design IT load)?

To be clear, there are more detailed questions to answer concerning EE monetization, and a company worthy of handling EE monetization that aims to measure and verify all of your data center's demand reduction company should ask them.

Understanding these questions and calculating answers for them will prepare your organization for when it comes time to work with CPower's experts who will help you monetize your EE projects.



An Example of EE Measure and Verification (M&V) for a Data Center

Now let's take a look at how power usage effectiveness and active IT load relate to a data center's energy efficiency potential.

For every 3,000 kW of active IT load, a data center that operates with a power usage effectiveness of 1.3 will likely save 1 MW of demand over an average PUE that can then be measured and verified as EE load. This permanent load reduction can then be monetized in an energy market like PJM.

As we've already discussed, that single MW of permanently reduced load has a significant impact on carbon reduction in the data center's local community.

A New Age for Data Centers and Demand Response

Until recently, most demand response strategies for the data center industry involved curtailing load and switching on a backup generator to power a facility for the duration of the event.

Effective as that tried-and-true approach may have been in the past, modern demand response presents data centers with a wealth of new opportunities that were previously unfeasible.

Like the data center industry itself, the practice of demand response continues to increase in sophistication to meet the needs of an evolving grid.

Let's take a few moments to explain how key assets in a data center's suite of DERs can play a starring role in a demand response strategy that can be lucrative from both an earnings and sustainability standpoint.

A data center's uninterruptible power supply (UPS) system ensures uptime by providing critical support during the precious moments between a power outage and a facility's backup generators firing up and synching.

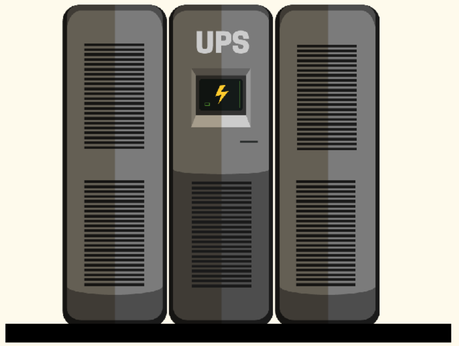
The same UPS system and its spare capacity can act as a bridge to uptime security can also help the electric grid before an outage takes place with modest load reductions using this stored energy, thereby keeping the data center and its surrounding community powered as well.

Across the US, new demand response programs are being launched that increasingly seek to incorporate storage resources as a means to help balance electricity demand with supply.

Many of these new programs' event durations are considerably shorter than those traditionally associated with demand response, which makes a data center's UPS system and its spare capacity a highly efficient resource for participation.

Exactly how a given UPS system can participate depends on more variables than this book can cover, including the system's parameters and those of the program itself.

The best way to assess whether your data center's UPS system is a candidate for DR participation is to consult a reputable demand-side energy management organization that can fully analyze your system and determine its potential on your region's available demand response programs.



The Uninterruptible Power Supply: distributed energy storage resources for demand response

FPO

Using a Generator for Demand Response Means Earning Revenue for Preparing it (and your staff) for a Real Emergency.

Sites that test their backup generators with a load bank typically do NOT test the transfer operations. If they do, they often don't test them under real-life circumstances to avoid inconveniencing the staff who will likely then be unprepared when a true emergency arises.

Organizations that use a generator as part of a demand response strategy can earn revenue for essentially testing their generators under the proper conditions.

By using a generator for demand response participation (either for a test or real event), you're not only using the generator's engine during a non-emergency situation since the grid is still up and supplying electricity, you're getting paid to ensure your generator will provide you the power you need when you need it—whether during a real power disruption on the grid or at your facility.

This approach ensures your generator will deliver resiliency when needed. At the same time, you're making sure your staff are practiced at running your generator and transferring load under real-life emergency conditions as opposed to an irregular time. Furthermore, using back-up generators for demand response often reduces net power grid emissions during these periods.

FPO

The CPower team can provide valuable insights about generator upgrades that can reduce emissions and further increase participation in these programs, furthering your facility and economic benefits and value to the grid.

Turning a Backup Generator into a Sustainability Promoter and Revenue Generator

A data center is an ideal candidate to earn revenue through demand response if its backup generator system:

1. is capable of handling large loads from several dozens of megawatts.

2. enables uninterrupted power supply (UPS) which allows for short-term frequency shifts or power reductions while the generator is activated.

Given the supreme need to be up and running at all times, most data centers' generator sets don't just provide full backup for every kilowatt the data center's systems demand. In many cases, they utilize N+1 redundancy, meaning they are equipped with excess generator capacity which exceeds the center's total peak demand.

Such high-capacity emergency generation systems put data centers in prime position to earn significant revenue with demand response, money that can be used, among other things, to offset a participating organization's hefty electricity bill, to fund upgrades to equipment or infrastructure, or to pass along to customers in the form of level rates.

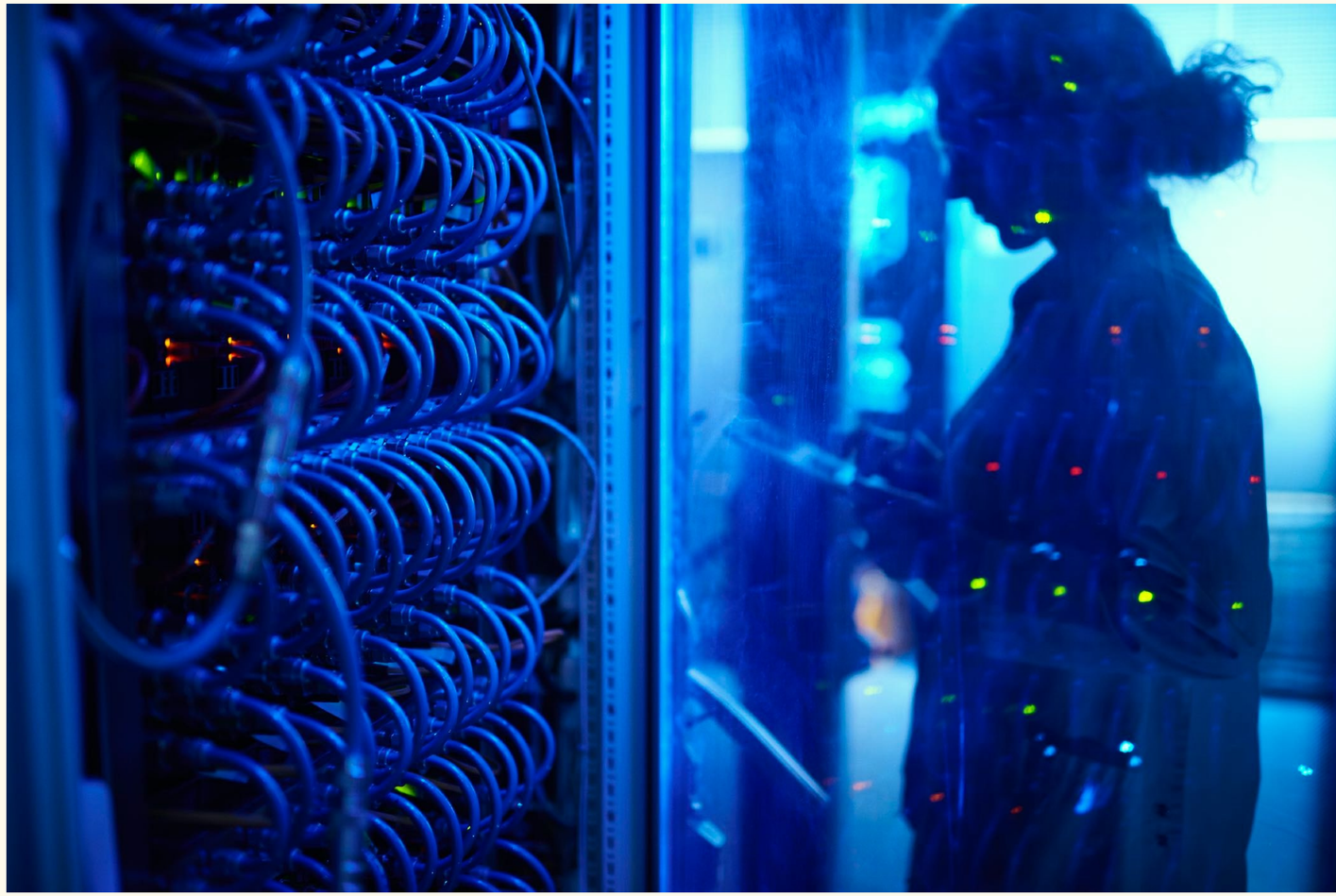
FPO

Learn more about how CPower helps Data Centers

Assessing Data Center Generators for Demand Response

One of the most important questions to answer concerning a data center's generators is whether the generators are eligible for demand response. Depending on where in the country a given data center resides, there are numerous regulations that determine if back-up generator can participate in a given demand response program.

It's important for data centers seeking to use a generator for demand response to partner with a licensed curtailment service provider (CSP) such as CPower that is familiar with energy laws in all deregulated markets as well as those enforced at the national level by the Environmental Protection Agency. CPower can help determine if a data center's generators are qualified to participate in demand response or need a few upgrades in order to participate.



FPO

Earning with Demand Response while Protecting Critical Operations

Like hospitals and other organizations whose uptime is critical to a given community, data centers are flush with backup generators that allow for large electrical loads to help the grid and the community without disrupting operations.

Because of their large electrical loads, data centers can earn significant sums of revenue with demand response. The smartest in the industry are doing just that with the help of a demand-side energy management company like CPower that is expert in assessing a given organization's unique facilities and setting them up with a strategic curtailment plan that guarantees the centers critical systems are always up and running while optimizing benefits.

FPO

Learn more about how CPower helps Data Centers

The Bridge to a Data Center's Energy Future

It is an exciting time for data centers.

Demand for data and a relentless rise in global computing have the industry on a trajectory of upward growth that shows no signs of slowing.

In this book, we've covered the fundamentals of how demand-side energy management can help a data center reduce its carbon footprint and help the grid during its current transition to a cleaner, more efficient, and dependable future.

Like the grid, data centers across the world are positioning themselves for a more sustainable tomorrow. Since no two data centers are alike, the specific ways in which a given data center can maximize its demand-side potential are many and unique to that data center.

The best way for your organization to learn the earning and sustainability potential of your energy assets is to contact and discuss your options with a reputable demand-side energy management company

The future of energy is calling. The journey across the bridge to energy's future begins with a single step.

Call us and let CPower's team guide your organization to optimized sustainability, costs, and uptime.

—The CPower Data Center Team

MATHEW SACHS
Senior Vice President of Strategic Planning and Business Development

KC MARES
Director | Data centers

DANIELLE BOND
Supervisor | Engineer

BERNADETTE WERNTGES
Senior Energy Engineer

NATE SOLES
Vice President | National

CPower

The Bridge To Energy's Future

CPowerEnergyManagement.com

844-276-9371